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made in correcting this situation is indicated by the fact that the classification of this report has been approved by the United States Geological Survey and is now official for the state surveys of Kansas, Iowa, and Nebraska with one minor exception in each of the last two states.

Lithologically, the series is made up chiefly of shales alternating with limestones. Sandstones, clay, and coal are found in lesser quantities. Most of the lithologic units are quite persistent laterally, but a few are notably lenticular. The broader features of the present structure have resulted from two periods of folding since the close of the Pennsylvanian. The first of these developed monoclinal dips to the west and northwest and the second formed a number of narrow anticlines with associated synclines. The axes of these folds are markedly parallel and trend northwest-southeast throughout the state. These are shown on a structure contour map drawn on the basis of rather meager data.

Invertebrate paleontology is the subject of an exhaustive chapter by Dr. Girty. More than 250 collections containing more than 350 species form the basis of his report. The species are listed by localities and by zones for each formation, and the valuable data of these lists is made available more readily by a composite table showing the range of each species. Descriptions and illustrations are given of a number of species that are new or have been called into question. Paleobotany is discussed in a short chapter by David White.

Some progress has been made in correlating the Missouri series with eastern areas. Paleontological evidence indicates that the lower part of the Cherokee is of Pottsville age and the upper part is basal Allegheny. It is suggested on the basis of incomplete collections that Allegheny time extends to the unconformity in the Pleasonton and that Conemaugh time ends well up in the Shawnee.

The writers of this valuable report did not fail to include a chapter of bibliography which includes all the important publications consulted in its preparation.

W. B. W.

The Red Iron Ores of East Tennessee. By ERNEST F. BURCHARD.
Bull. Tenn. Geol. Survey No. 16, 1913. Pp. 173, pls. 17
(including 5 maps), figs. 30 (including 6 maps).

The purpose of this report is to describe and explain the origin of the red iron ores as they occur in the Cumberland Plateau and the Great Valley in east Tennessee.

It is not possible to give a generalized section of the strata in east Tennessee because of the local variations in the sequence. The ores are contained chiefly in the "Rockwood" formation (Silurian). They are found also in the Tellico sandstone (Ordovician) and to a very minor extent in the Grainger shale (Devonian and Mississippian). Two widespread formations, the Knox dolomite (Cambrian and Ordovician) and the Chickamauga limestone (Ordovician), occur below the Tellico and "Redwood." The Chattanooga shale (Devonian) and the Newman limestone (Mississippian) which lie above the "Rockwood" are important, the former as a reference horizon for the "Rockwood" ore and the latter as a source of the limestone for fluxing material in the iron industry.

In general the beds of the Cumberland Plateau are nearly horizontal, while those of the Great Valley are tilted, folded, and faulted.

The term iron ore as used in this report includes that which runs 20 or more per cent metallic iron. The red ores consist essentially of hematite; the impurities are calcium carbonate, silica, alumina, magnesium carbonate, sulphur, phosphorus, and manganese.

The Tellico ore varies from a ferruginous sandstone to lenses of compact rich ore. The deposits near Riceville, near Sweetwater, and east of Knoxville (here the ore is dominantly limonite) are described; the two last mentioned are residual deposits.

The "Rockwood" formation is composed of lenses of sandstone, shale, limestone, and hematite; its thickness varies from a few feet to over 1,000 feet. The ore beds are mainly in the upper 60-200 feet. The ore is "a mixture of fossil fragments and flaxseed-shaped grains." The soft ore (due to the leaching of calcium carbonate from hard ore) carries 40 to 58 per cent metallic iron, while the hard ore runs from 25 to 45 per cent metallic iron. It is believed "that the 'Rockwood' iron ore was formed by the deposition in a body of water of sediments containing iron, together with calcium carbonate, silica, alumina, and other minerals in minor proportions." Later much of the calcium carbonate of the fossils was replaced by iron oxide; this may have occurred even before the consolidation of the strata and "it probably involved only the original sediments." The "Rockwood" ore outcrops more or less continuously along the base of the Cumberland escarpment and in the Tennessee Valley; the total linear exposure, if only a single seam is taken into account, is 245 miles, of which 60 miles is workable hard ore.

Central east Tennessee is the most productive area in the state.

Underground (slope and adit) mining is carried on almost exclusively.

"Notes on the Iron Industry" conclude the report.

V. O. T.